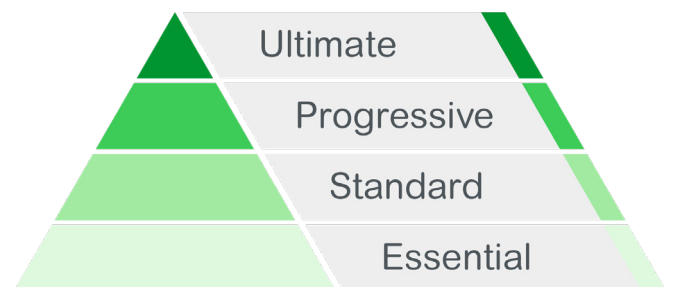


Step-by-step transition to a sustainable **FUTURE**

Schneider Electric EcoStruxure™ ADMS

Significant efforts are being made across the world to promote clean energy and environmental protection. Digital transformation of the power grid to boost clean energy puts the smart grid industry to the test. New types of energy sources, their distributed location, load and generation volatility, demand pattern changes, energy policies change, new reliability requirements, increasing end customers expectations, and the evolving business revenue models, present new challenges for utilities. They are under constant pressure to operate more efficiently and safely while modernizing the grid and delivering improved services to their customers. To cope with these tremendous changes, distribution utilities need to take an active role in managing their systems and adapt to varying conditions in real-time. Only a comprehensive set of specialized software tools integrated into a robust solution can handle these challenges and ensure a smooth transition – from traditional, paper-driven processes to a digital and adaptive way of managing grids in real time. Utilities of the future require a complete understanding of current and future network states that would enable them to respond to known and unexpected events safely and efficiently. These capabilities are now offered through an Advanced Distribution Management System (ADMS).

Schneider Electric's EcoStruxure™ ADMS helps utilities tailor their path by gradually tackling individual challenges with a stepwise deployment approach, depending on their digital maturity and strategic business goals. Essential and Standard offers address the primary use cases, while Progressive and Ultimate offers address more challenging ones. Schneider Electric's four pillars of the ADMS enable greater sustainability by confronting today's techno-social and climate changes: Operational Efficiency, Reliability & Resilience, Grid Efficiency, and Grid Flexibility. This paper will delve into details of the four value pillars and associated stages in a utility's journey to sustainability.

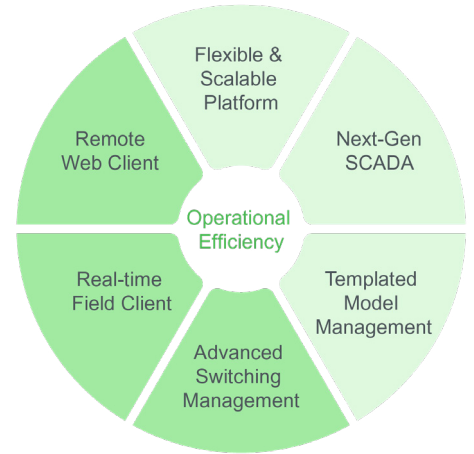


Utilities are taking the vital leap towards adoption of digital game-changing technologies. The key to ensure success and future sustainability is to have comprehensive, modern, and agile management of grid and field operations enabled by a higher degree of digitalization. This will provide greater visibility of the grid, process automation, advanced intelligence, and analytics.

Operational Efficiency

Improving operations is a continuous initiative and combined effort to optimize processes, people, finances, and technology. The real indicators of enhanced operational efficiency are intelligent asset allocation, higher utilization rates, the culture of safety, and a myriad of other factors.

Sometimes, when under financial pressure, utilities decide to take the matter into their own hands by developing an in-house solution to help achieve higher levels of operational efficiency. However, developing such software platforms typically prevents utilities from adopting future technologies, forces implementation of proprietary components and protocols, limits expanding the software system as a company's portfolio and size change, and overall increases the Total Cost of Ownership (TCO).



Utilities with a custom software platform cope with complex and non-consistent processes and are forced to invest considerable efforts in orchestrating all activities. Thus, the cornerstone of operational efficiency is a streamlined, standardized, and agile management system that is deployable out-of-the-box.

The ADMS replaces a legacy control center software used to operate an electric distribution system with an integrated technology platform, enabling step-level improvements in the utility's ability to monitor, manage, and control its network. Such replacement bolsters the utilities in achieving their operational excellence.

Essential

Schneider Electric offers a complete portfolio of modules to increase operational efficiency. It starts with the EcoStruxure™ ADMS Next-Gen SCADA

– a dedicated module used for grid model management, telemetry, and graphical displays with support for incremental configuration changes and a powerful engine for testing, validating, and promoting changes. One of the most significant advantages of the EcoStruxure™ ADMS Next-Gen SCADA module is its Protocol Analyzer, fully embedded communication troubleshooting tool that eliminates need for any additional 3rd party software. It reduces the total cost of ownership and improves efficiency for data commissioning, while it can also be utilized as a learning tool.

Ensure savings of at least 250k hours over a 10-year period for SCADA telemetry commissioning.

The lifeblood of every digital system is the data and a model tailored from it. The suite has a fully embedded automated model management subsystem built for a highly secure, configurable, standardized, and robust model update process. Model management utilizes bi-directional, standards-based interfaces, consistent user experience, and a common network model for all voltage levels, all grid configurations, and all geographies, having a powerful data defaulter that can significantly speed up the model build process. For data visualization and changes, Dynamic Mimic Diagram (DMD) and Network Builder applications are used, as an integral part of the EcoStruxure™ ADMS, genuinely offering a single pane of glass. The same user experience is available, not just for SCADA functionalities, but across all modules and applications. Next to the standard SCADA functionalities, Load Shedding, and rule-based Volt-Var Optimization applications are available within the Essential offer.

"PG&E's implementation of an Advanced Distribution Management System (ADMS) is a foundational, no-regrets investment that will transform the organization's ability to meet customer expectations – now and into the future."

- Pacific Gas and Electric Company

se.com

Life Is On

Schneider Electric

ESSENTIAL	STANDARD	PROGRESSIVE	ULTIMATE
<ul style="list-style-type: none"> ✓ Grid Operations Platform ✓ Next-Gen SCADA ✓ Single Pane of Glass HMI ✓ Templated Model Management ✓ Load Shedding ✓ Volt Var Optimization (CVR) ✓ ICCP ✓ DNP3 ✓ IEC 101 ✓ IEC 104 Advanced Switching Management Field Client WebDMD Forecast (NT, ST, MT) Big Data Connector LV Network Model IEC 61850 <p>Available addons</p> <ul style="list-style-type: none"> ArcFM Data Exporter OSIsoft PI Historian Integration Conitel, DNP3 Slave, IEC 101 Slave, MD3, MODBUS, Series 5, VANCOMM 	<ul style="list-style-type: none"> ✓ Grid Operations Platform ✓ Next-Gen SCADA ✓ Single Pane of Glass HMI ✓ Templated Model Management ✓ Load Shedding ✓ Volt Var Optimization (CVR) ✓ ICCP ✓ DNP3 ✓ IEC 101 ✓ IEC 104 ✓ Advanced Switching Management ✓ Field Client ✓ WebDMD ✓ Forecast (NT, ST, MT) Big Data Connector LV Network Model IEC 61850 <p>Available addons</p> <ul style="list-style-type: none"> Switching Management Reporting Integration 	<ul style="list-style-type: none"> ✓ Grid Operations Platform ✓ Next-Gen SCADA ✓ Single Pane of Glass HMI ✓ Templated Model Management ✓ Load Shedding ✓ Volt Var Optimization (CVR) ✓ ICCP ✓ DNP3 ✓ IEC 101 ✓ IEC 104 ✓ Advanced Switching Management ✓ Field Client ✓ WebDMD ✓ Forecast (NT, ST, MT) ✓ Big Data Connector ✓ LV Network Model IEC 61850 <p>Available addons</p> <ul style="list-style-type: none"> Switching Management Notification Integration 	<ul style="list-style-type: none"> ✓ Grid Operations Platform ✓ Next-Gen SCADA ✓ Single Pane of Glass HMI ✓ Templated Model Management ✓ Load Shedding ✓ Volt Var Optimization (CVR) ✓ ICCP ✓ DNP3 ✓ IEC 101 ✓ IEC 104 ✓ Advanced Switching Management ✓ Field Client ✓ WebDMD ✓ Forecast (NT, ST, MT) ✓ Big Data Connector ✓ LV Network Model IEC 61850

Standard

Fieldwork requires strong collaboration between field crews and the control room to ensure field personnel and equipment safety. Control room operators must prepare and validate switching plans, ensure that affected customers are promptly detected, coordinate activities between different crews, track work progress and crew locations, and update real-time network statuses. As a result, the control room personnel's workload significantly increases, and the switching process becomes error prone. To improve safety, raise operational awareness, and reduce control room personnel's workload, a higher level of operational efficiency is needed.

Improve crew safety, along with productivity by 60% using the advanced switching management and real-time field client.

Schneider Electric's EcoStruxure™ ADMS offers a set of fully integrated applications that help utilities to improve in that area even more: Advanced Switching Management module and built-in Field Client and Web Dynamic Mimic Diagram (Web DMD). The switching management module provides a fully digitalized business process for managing planned and emergency switching activities in the system safely and efficiently. It supports the end-to-end process, including submitting requests to work on/near utility assets, writing switching plans in real-time and study mode, and coordinating between different stakeholders during switching plan execution. In addition, it uses advanced applications' intelligence to automatically detect isolation/protection points and validate switching steps. The module is configurable to completely adapt to the existing control room procedures, including the lifecycle of the switching plans.

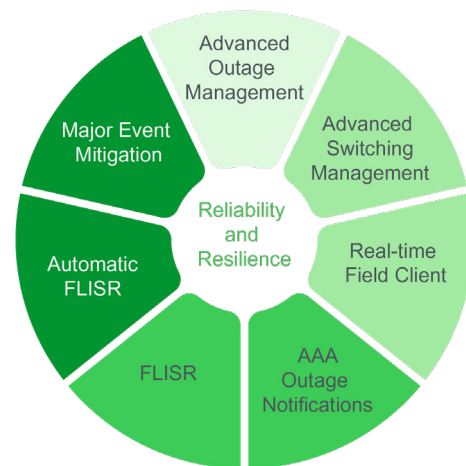
Switching management leverages the Field Client mobile application and allows smooth coordination between the control room and the field. As a result, dozens and possibly hundreds of field crew members can operate the network safely, with the ability to locate themselves on the map and continuously view the up-to-date network topology as it changes in real time, realizing the benefits of switching validations before operating a device, being instantly informed when new assignments are received, and previewing all details about the assigned work. Furthermore, with the insight into other work locations nearby, crews gain more autonomy to organize their work. Also, they can record performed operations and with online integration data is instantly available in the control room making the process of updating crew tasks automatic. This enables the control room personnel to track the progress of ongoing work, having the actual state of the network transparent at all times, for all stakeholders, without communication overhead.

Progressive & Ultimate

Finally, the ultimate level of operational efficiency is reached by unlocking additional value. The utility has the tools to effectively improve grid reliability, meet security and compliance requirements, and save costs. To build modern, future-proof, and secure communication with modernized substations, the Ultimate stage of the EcoStruxure™ ADMS Operational Efficiency package supports the IEC 61850 protocol. The IEC 61850 is the backbone of the smart grid, and the Schneider Electric EcoStruxure™ ADMS is the first ADMS to speak 61850 natively to field devices from the control room. It offers a high level of secure communication within an integrated, scalable solution that runs on a flexible platform and improves cybersecurity compared to segregated systems. Furthermore, the off-the-shelf interface enables streaming real-time data from ADMS to various analytics systems via the Big Data Connector, additionally lowering the total cost of ownership.

Reliability & Resilience

Reliability is the utility's most important duty. It is about designing, running, and maintaining an electricity supply to provide an adequate, safe, and stable flow of electricity – “keeping the lights on”. Resilience expands the concept of reliability, and it is about preparing for, operating through, and recovering from significant disruptions, regardless of the cause. Ultimately, it is about the system's ability to withstand extreme or prolonged critical events.



Schneider Electric EcoStruxure™ ADMS provides several layers through which utilities can increase their reliability and resilience. With the increasing number of requirements from utilities to accurately track and report outages, outage management system (OMS) has become a critical analysis tool. Unfortunately, traditional grid outage management systems have two fundamental flaws: they lack an accurate, current representation of the grid network model, and they typically do not integrate with the systems that monitor and control the actual grid. These shortcomings result in more prolonged outages, higher costs, and lower levels of customer service.

Essential

At the core of the Essential offer is the set of applications for advanced outage management which include Crew Management, Outage Management, Reliability Reporting, Damage Assessment, Post-mortem Analysis in simulations, and Basic Switching Management. Schneider Electric EcoStruxure™ ADMS OMS module is a fully integrated and highly configurable outage management module. However, for utilities that are beginning their digitalization journey, OMS can be implemented as a standalone solution (independently of other ADMS subsystems like SCADA, DMS, etc.). Additionally, Essential offer provides the capability of integrating EcoStruxure™ ADMS OMS with a 3rd party SCADA system via ICCP integration. Operators can easily input trouble calls and incidents manually to capture events. Utilizing the optimal crew dispatch algorithm within OMS module, crew safety is enhanced with lower management efforts. Such algorithms consider factors like distance to travel, crew workload, and skillset, allow operators to quickly identify and assign the most suitable crew, improve productivity, and reduce travel time, thus reducing the overall duration of outages. In addition, Essential package also offers basic damage assessment and work verification capabilities. All of the above-mentioned functionalities are also available within Dispatcher Training Simulator (DTS/OTS) module through which learning for new members is significantly elevated.

"In today's connected world, customers can't imagine that a utility would have to wait for a customer call to know that their power is out."

- U.S. Department of Energy

Climate change already has noticeable effects on the world. Due to these effects, utilities cope with lower reliability, higher expenses, and more power outages. Many utilities are not ready because the current infrastructure is built for historical weather conditions and are more vulnerable to future extremes. Utilities strive for an improved response time to outages and the ability to anticipate incidents in order to improve customer service (SAIDI, SAIFI) and ensure consistent power quality (mostly regulation-driven) by greater grid automation. The system must be ready to mitigate major events, maintain energy flow and ensure the grid's digital and physical security. The goal is to move from reactive to preventive operations & maintenance.

ESSENTIAL	STANDARD	PROGRESSIVE	ULTIMATE
<ul style="list-style-type: none"> ✓ Advanced Outage Management ✓ Single Pane of Glass HMI ✓ Templated Model Management ✓ ICCP Advanced Switching Management Real-time Field Client Web Control Center (WebCC) WebDMD CRM & IVR Integration AMI Integration Outage Status & Reporting Integration AVL Integration FLISR AAA Outage Notifications Fire Mitigation LV Network Model Visibility Outage Portal Integration Workforce Management Integration Automatic FLISR Automatic Fire Mitigation <p>Available addons ArcFM Data Exporter</p>	<ul style="list-style-type: none"> ✓ Advanced Outage Management ✓ Single Pane of Glass HMI ✓ Templated Model Management ✓ ICCP ✓ Advanced Switching Management ✓ Real-time Field Client ✓ Web Control Center (WebCC) ✓ WebDMD ✓ CRM & IVR Integration ✓ AMI Integration ✓ Outage Status & Reporting Integration ✓ AVL Integration FLISR AAA Outage Notifications Fire Mitigation LV Network Model Visibility Outage Portal Integration Workforce Management Integration Automatic FLISR Automatic Fire Mitigation <p>Available addons Site Notes Integration</p>	<ul style="list-style-type: none"> ✓ Advanced Outage Management ✓ Single Pane of Glass HMI ✓ Templated Model Management ✓ ICCP ✓ Advanced Switching Management ✓ Real-time Field Client ✓ Web Control Center (WebCC) ✓ WebDMD ✓ CRM & IVR Integration ✓ AMI Integration ✓ Outage Status & Reporting Integration ✓ AVL Integration ✓ FLISR ✓ AAA Outage Notifications ✓ Fire Mitigation ✓ LV Network Model Visibility ✓ Outage Portal Integration Workforce Management Integration Automatic FLISR Automatic Fire Mitigation <p>Available addons Switching Management Integrations</p>	<ul style="list-style-type: none"> ✓ Advanced Outage Management ✓ Single Pane of Glass HMI ✓ Templated Model Management ✓ ICCP ✓ Advanced Switching Management ✓ Real-time Field Client ✓ Web Control Center (WebCC) ✓ WebDMD ✓ CRM & IVR Integration ✓ AMI Integration ✓ Outage Status & Reporting Integration ✓ AVL Integration ✓ FLISR ✓ AAA Outage Notifications ✓ Fire Mitigation ✓ LV Network Model Visibility ✓ Outage Portal Integration ✓ Workforce Management Integration ✓ Automatic FLISR ✓ Automatic Fire Mitigation

Standard

The additional value of OMS comes with the synergy with Advanced Switching Management and EcoStruxure ADMS Next-Gen SCADA modules. Having all three modules tightly integrated, running on a common platform, with a single pane of glass and a common (single) network model ensures greater availability, scalability, situational awareness, and minimizes the total cost of ownership. The ability to integrate OMS with various external systems (call centers, AMI head-end systems, outage portals, IVR systems, customer relationship management systems, and others) via standards-based (IEC 61968 and IEC 61970 series) interfaces to collect various types of inputs such as trouble calls, smart meter events, outage portal notifications and others, additionally enhances the precision of outage prediction and verification of the outages' extent. Customer Service Representatives in call centers can rely on the integrated Web Call Center application for customer trouble call submitting, callback handling and incident information providing.

Accurate tracking of outages and associated issues is achieved by adaptive information grouping and visualization. In addition, identifying affected customers and numerous outage statistics, predicted, and confirmed damages, or any issues in the field provides operators with complete situational awareness. This results in an efficient response to a disturbance and rapid implementation of necessary actions to minimize the overall outage duration.

The OMS foundation resides on a complete network model (including all voltage levels) created through a standards-based integration with countless GIS, CIS systems and sustainable Model Management process that ensures accurate, up-to-date, accessible model with proper topology and customer information, allowing correct tracking of the customers affected by outages.

Advanced Switching Management represents the core of the Standard offer. Besides improving operational efficiency, Switching Management also advances reliability & resilience by reducing reaction time to outages and helping operators anticipate critical events. In addition, switching management imposes reliability by accurately capturing switching steps for telemetered and non-telemetered devices. All switching operations performed in the incident lifecycle are recorded, and restoration statistics are calculated and tracked to the individual customer location. By using the advanced outage management with an embedded intelligent prediction engine, fully digitized switching management, built-in field, and web clients, the utility can improve its distribution grid management, taking effect in both high-activity and blue-sky scenarios.

Progressive

Starting with the Progressive offer, the next level of Reliability & Resilience improvements is available. By unlocking this level, utilities can use Fault Location, Isolation and Supply Restoration (FLISR) to additionally optimize the restoration of outages. FLISR is a suite of applications used to mitigate the impact of permanent faults on distribution systems and ensure high overall system reliability.

EcoStruxure™ ADMS FLISR is the most comprehensive solution that handles faults for all types of the primary distribution feeders (radial, parallel, meshed) and in the primary substations of sub-transmission networks. It provides the fault location using all available equipment in the network, including AMIs and trouble call information. The supply restoration provides the optimum variant,

considering pre-fault, current data, and the forecasted network state. The solution is optimized from a performance point of view. The appropriate telemetry/communication guarantees the outage restoration to be below one minute, including the reclosing operation, for any size and complexity of the electrical network. EcoStruxure™ ADMS FLISR is highly configurable. The baseline product supports different network types in Europe, America, Australia, Asia, including various utility practices and business procedures.

FLISR can be executed manually or automatically, but its automatic execution is available only in the Ultimate edition. Automatic FLISR brings an algorithm for major event mitigation.

Wildfires have caused significant social and economic damage worldwide, and they are growing in scale, intensity, and duration. Utilities are now facing challenges of how to align two, in some cases, conflicting regulatory requirements. The first one is to reduce wildfire risks and keep customers and communities safe, while the second requirement is to keep lights on and maintain the high quality and reliability of supply, quantified through SAIDI and SAIFI indices. During wildfires and other significant events like floods, heavy snow, storms, the utilities must identify and perform the extreme weather mitigation steps by implementing various measures. Those measures are related to the protection and switching operations based on the real-time as-operated network topology, the information from geographic maps, and the forecasted risk rating information from the meteorology services.

In addition to resolving the above listed challenges with FLISR and Fire Mitigation, the Progressive package provides the solution for keeping information-hungry stakeholders well informed about the existing outages. With the help of Advanced, Automated and Adaptive (AAA) Outage Notifications, utilities can respond to increasing customer' expectations by providing accurate, personalized, consistent and timely outage communication. Flexible and secure communication channels, personalized notification templates (both for email and SMS) and a variety of persona-based recipients, are just some of the key features included within the AAA Outage Notifications through which additional value is delivered, on top of which total cost of ownership can be reduced up to 1M€ annually.

“To be able to restore power to the majority of customers on a feeder in under a minute is something that has never been done in the history of SA Power Networks. Without Schneider, we probably would not have progressed as far as we have and as quickly as we have.”

Tasnim Abdel-Razar
Network Control Manager
SA Power Networks

Keep information-hungry stakeholders well informed all the time, while saving up to 1M€ yearly using advanced, automated and adaptive outage notifications.

Ultimate

EcoStruxure™ ADMS Fire Mitigation application of the Ultimate edition automates the identification process of preventive actions based on the real-time as-operated network topology and the information from mitigation area maps and near-real-time or forecasted risk rating information from meteorology. After identifying the process, the application can execute preventive actions for SCADA-enabled devices with minimum or no operator involvement. When the severe risk is over, the fire mitigation applications return the entire network operations to normal.



Energy efficiency is a superior measure that a utility uses to ensure customer satisfaction by providing reliable and quality power delivery while keeping the electricity tariffs affordable.

Grid Efficiency

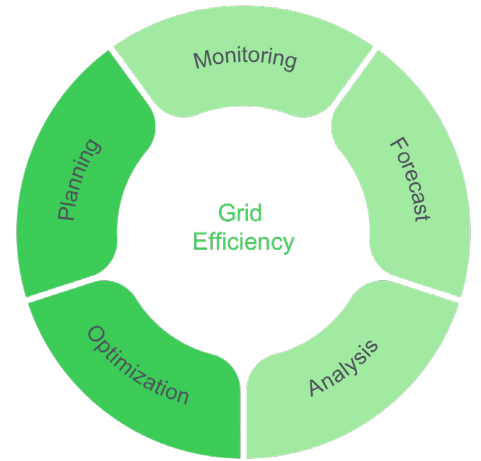
A kilowatt saved is worth more than a kilowatt supplied. This is because a utility avoids transmission and distribution infrastructure costs and line losses as well as the reserve capacity needed to assure reliable service. By avoiding CO2 emissions direct environmental benefits crucial for fighting climate change are also generated.

Smart grid technologies serve a utility by enabling optimized and efficient management of electric power system that maximizes the utilization of existing grid assets, optimizes power flows and defers capital investments.

The key to efficient grid management is a rich and proven portfolio of advanced power applications. However, running custom power applications can impact optimality and stability of the grid management solution, due to their uncertain life cycle and support period, the need to maintain multiple network models and inconsistent look and feel. A comprehensive and mature product that incorporates years of experience from utilities dealing with the same challenges worldwide can overcome these missed value streams and deteriorated performance.

Schneider Electric EcoStruxure™ ADMS delivers a portfolio of state-of-the-art distribution applications that provide full real-time view of the entire network and insight into the forecasted network state, enabling holistic system analysis and optimization, as well as powerful what-if and planning analysis.

A field-proven set of automatic grid optimization applications can significantly benefit customers and the environment through increased network capacity, safety, and energy savings. With Schneider Electric EcoStruxure™ ADMS, utilities can satisfy the evolving customer needs for electricity delivery and power quality through safe, reliable, and efficient distribution network operation. By fully supporting low and high voltage levels in addition to the medium voltage level, EcoStruxure™ ADMS is designed to fit the needs of any distribution utility around the world, including the ones that are planning and operating the sub-transmission part of the electric system, as well as low-voltage grid typical for urban areas.



Essential

In the Essential offer, utilities can run fundamental applications to improve situational awareness. State estimation provides full insight into the non-observable parts of network by combining SCADA data and historical customer load profiles, as well as AMI and weather data when available. As a result, the loading level, voltage profile and hidden load is available for any point on the distribution feeder. This is particularly useful for areas with high solar penetration where voltage and loading conditions are variable throughout the day. Key performance indices derived from state estimation results provide simple and actionable monitoring of overall conditions in the grid.

ESSENTIAL	STANDARD	PROGRESSIVE	ULTIMATE
<ul style="list-style-type: none"> ✓ Core DMS Apps ✓ Core EMS Apps ✓ Single Pane of Glass HMI ✓ Templated Model Management ✓ ICCP Load Profile Generator Thermal Monitoring (Automatic) Volt Var Optimization Network Reconfiguration Load Relief Advanced Switching Management Forecast (NT, ST, MT) Optimization & Constraint Mng. Contingency Analysis WebDMD Adaptive Relay Protection Reliability Analysis EMS Look-Ahead Contingency Analysis EMS Relay Protection Large Area Restoration (LAR) LV Network Model & DMS EMS Fault Analysis Network Planning EMS Voltage Stability Automatic Protection Automatic LAR, NR & Load Relief DMS Planning Applications LV optimization & analysis apps <p>Available addons</p> <ul style="list-style-type: none"> AMI Integration ArcFM Data Exporter 	<ul style="list-style-type: none"> ✓ Core DMS Apps ✓ Core EMS Apps ✓ Single Pane of Glass HMI ✓ Templated Model Management ✓ ICCP ✓ Load Profile Generator ✓ Thermal Monitoring ✓ (Automatic) Volt Var Optimization ✓ Network Reconfiguration ✓ Load Relief ✓ Advanced Switching Management ✓ Forecast (NT, ST, MT) ✓ Optimization & Constraint Mng. ✓ Contingency Analysis ✓ WebDMD Adaptive Relay Protection Reliability Analysis EMS Look-Ahead Contingency Analysis EMS Relay Protection Large Area Restoration (LAR) LV Network Model & DMS EMS Fault Analysis Network Planning EMS Voltage Stability Automatic Protection Automatic LAR, NR & Load Relief DMS Planning Applications LV optimization & analysis apps <p>Available addons</p> <ul style="list-style-type: none"> Load Profile Updater CIM Network Export (from ADMS) 	<ul style="list-style-type: none"> ✓ Core DMS Apps ✓ Core EMS Apps ✓ Single Pane of Glass HMI ✓ Templated Model Management ✓ ICCP ✓ Load Profile Generator ✓ Thermal Monitoring ✓ (Automatic) Volt Var Optimization ✓ Network Reconfiguration ✓ Load Relief ✓ Advanced Switching Management ✓ Forecast (NT, ST, MT) ✓ Optimization & Constraint Mng. ✓ Contingency Analysis ✓ WebDMD ✓ Adaptive Relay Protection ✓ Reliability Analysis ✓ EMS Look-Ahead Contingency Analysis ✓ EMS Relay Protection ✓ Large Area Restoration (LAR) ✓ LV Network Model & DMS ✓ EMS Fault Analysis ✓ Network Planning ✓ EMS Voltage Stability Automatic Protection Automatic LAR, NR & Load Relief DMS Planning Applications LV optimization & analysis apps <p>Available addons</p> <ul style="list-style-type: none"> Long-Term Forecast EMS Voltage Stability 	<ul style="list-style-type: none"> ✓ Core DMS Apps ✓ Core EMS Apps ✓ Single Pane of Glass HMI ✓ Templated Model Management ✓ ICCP ✓ Load Profile Generator ✓ Thermal Monitoring ✓ (Automatic) Volt Var Optimization ✓ Network Reconfiguration ✓ Load Relief ✓ Advanced Switching Management ✓ Forecast (NT, ST, MT) ✓ Optimization & Constraint Mng. ✓ Contingency Analysis ✓ WebDMD ✓ Adaptive Relay Protection ✓ Reliability Analysis ✓ EMS Look-Ahead Contingency Analysis ✓ EMS Relay Protection ✓ Large Area Restoration (LAR) ✓ LV Network Model & DMS ✓ EMS Fault Analysis ✓ Network Planning ✓ EMS Voltage Stability ✓ Automatic Protection ✓ Automatic LAR, NR & Load Relief ✓ DMS Planning Applications ✓ LV optimization & analysis apps

Standard

To keep pace with the energy efficiency initiatives, utilities can use Volt Var Optimization (VVO) techniques to reduce energy losses and the demand on the electric distribution system, as well as to ensure consistent quality of the power delivered to end customers. EcoStruxure™ ADMS VVO available in the Standard package offer is the most comprehensive solution for centralized automatic management of voltage levels and reactive power flows in the distribution grid. It provides leveled voltage profile for all customers, reduced energy losses and energy savings, as well as VAR support and peak demand shaving for the needs of transmission.

The VVO power application supports rule-based decision making that utilizes SCADA and/or AMI data as its input, as well as model-based decision making that considers the estimated state in addition. Having both approaches enable utilities to gain benefits early in the project by fast large-scale commissioning of the rule-based VVO and then move gradually to the model-based approach to leverage the full potential of available Volt and Var devices and guarantee adequate voltage level at any point in the grid. To ensure seamless and successful VVO implementation, EcoStruxure™ ADMS VVO provides out-of-the-box interface that supports all types of controls of LTCs, voltage regulators and capacitors, as well as out-of-the-box reporting of the gained Conservation Voltage Reduction (CVR) benefits.

One common request among utilities is to quickly get a solution for transferring some part of the network to the adjacent source without any violation, based on the load that needs to be transferred. Furthermore, handling the overload conditions or unwanted reverse flow conditions on some part of the network in a real-time environment can be challenging because it needs to be performed as quickly as possible and it may need to account for the possible load hidden by the local solar generation. In addition, it is demanding in terms of the quality of the power supply (no new overload and reverse flow conditions, voltage quality issues, or customer de-energization events should occur because of the operator's interference). The EcoStruxure™ ADMS Load Relief application is designed as part of the automated control room package. It is oriented towards real-time monitoring of the distribution network conditions to provide an automatic response when a new overload or reverse flow condition occurs. The application's primary goal is to provide accurate and up-to-date results (following the latest dynamic changes in the network) and the optimal switching plan to neutralize unwanted conditions in the network.

Estimated benefits of EcoStruxure ADMS optimization apps for a utility with 2.5M customers are:

- VVO: 3m€
- Network auto-reconfiguration: 10m€
- Large area reconfiguration: up to 30m€

One of Schneider Electric customers from Europe reported:

- Avoided energy losses of 4% per year (144 GWh and 75000 tCO₂)
- Cost reduction of 5.7 m€/year

In addition to the above-mentioned features, Standard package offers a solution that can address the challenge of different levels of power demand throughout the day and across seasons. These load changes have an impact on the optimal locations of the normally open (NO) switches. The EcoStruxure™ ADMS Network Reconfiguration (NR) application, available in the Standard offer, is used to test any network state and obtain the appropriate solution for the optimal location of the NO switches. As a result, the optimal radial distribution network configuration (location of the normally open switches) is achieved under the selected optimization objective.

US utility generated 173 GWh of energy savings in the period of two years (~\$10M USD) by using EcoStruxure ADMS VVO.

Progressive

The Progressive edition unlocks a higher level of grid automation and optimization through the EcoStruxure™ ADMS Large Area Restoration (LAR) application. This application allows the operator to mark faulted equipment in the HV/MV (primary) substations, sub-transmission, and transmission networks. The application then suggests switching actions to isolate faulted assets (if needed) and restore power to the healthy part of the network. Besides LAR, the Progressive edition includes other advanced applications for additional efficiency improvement like Protection Analysis, Reliability Analysis, and Long-Term Forecast, as well as support for the LV network model for improved visibility of the entire grid.

The Progressive offer, with its dedicated tools, also improves Network Planning. The objective of distribution network planning as a business process is to provide an orderly and economic expansion of equipment and facilities to meet the electric utility's future electrical demand with an acceptable level of reliability and power quality. In the broadest sense, the planning is done so the utility can both meet its obligations and attain the desired performance. Therefore, the planning is almost always goal-directed – aimed at achieving some objective. Network Planning is a module of EcoStruxure™ ADMS. It allows planning engineers to develop studies and plans for future network development in the timeframe of several days to several years. Using the new Network Builder planning mode, engineers can create, edit, save, and manage planning studies with multiple variants, placed into a specified future timeframe, and analyze the effects of the behavior of each planned state using other EcoStruxure™ ADMS power applications. Users can create multiple studies, each consisting of one or multiple variants of the future development. Effective comparison of technical and economical KPIs related to different variants enables reasoned and efficient decision making.

Ultimate

A holistic approach for the grid management and synergy of all ADMS applications and modules is achieved with the Ultimate edition. The model-based optimization with full insight into the grid conditions enables smart and preventive management of the grid. The full suite of analysis, optimization and planning techniques that share the same network model, historical data and look and feel satisfies the needs of every engineering and planning department while reducing the total cost of ownership. The automated and semi-automated approaches are available so that the issue detection and resolution, as well as the grid optimization techniques are seamless for the operator. EcoStruxure™ ADMS Automatic Protection, Automatic Large Area Restoration and Automatic Load Relief are the Ultimate edition applications at an operator's disposal to extract the maximum benefit from the investments in grid automation, telemetry, and software. In a dynamic distribution grid relay protection settings may not be adequate for all conditions, introducing the risks of unnecessary device tripping, diminished sensitivity to detect faults and inadequate coordination of protective devices, all leading to deteriorated system reliability. EcoStruxure™ ADMS Automatic Protection implements continuous real-time verification of protection settings, identifies protection devices whose setting is not adequate for an existing network condition and finds the optimal one among the pre-defined settings which enables the operator to update inadequate settings as soon as possible.

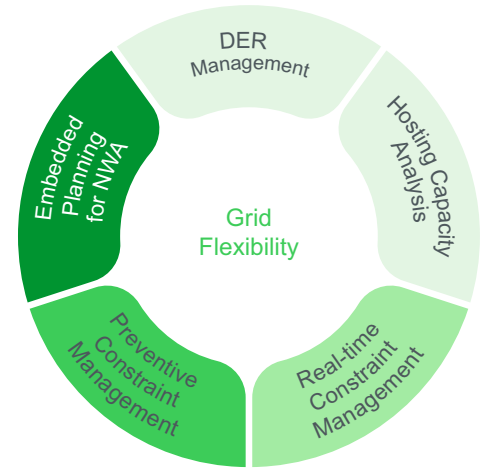


The distribution network is shifting towards a future with much higher penetration of distributed energy resources (DERs). This shift is driven by the changes in customer choices around energy and technological development leading to lower costs and better performance of DER. New policies and regulatory proceedings are requiring utilities and utility customers to embrace DERs in many forms. All these changes relate to the ultimate goal of reaching zero CO₂ emissions and limiting the global temperature rise below 1.5-2°C in the 21st century, as prescribed by the Paris Agreement.

Grid Flexibility

Managing distribution grid planning and operation, electric utilities are a key enabler of this clean energy transition and are facing considerable challenges on their journey of integrating DERs. The success shall be measured by reaching a fully flexible electricity grid that can host all DERs of today and the future.

Schneider Electric's Grid Flexibility package is a fundamental building block in the strategy towards DER integration. By covering both flexible grid planning and operation, the solution represents a complete, innovative, and grid-aware answer for orchestrated dispatching of DERs to manage and optimize the grid while releasing network capacity.



Essential

As the increased number of DERs start to have impact on the grid causing grid constraint violations, such as overvoltage and thermal overload conditions in areas with higher penetration of renewable generation, the first functionality needed is DER awareness. The Grid Flexibility package in the Essential offer includes the Hosting Capacity Analysis application for the planning department as well as the core DER monitoring, aggregation and manual dispatch functionalities for the grid operations. DER management directly communicates to single DER units, enables their aggregation and interfaces 3rd-party-aggregated DERs making it an overarching interface for DER management. The supported DERs include all types of generation, energy storages, electric vehicles, microgrids and demand programs.

Hosting Capacity application provides insight into the amount of distributed renewable generation that can be installed in the grid without creating congestions, as well as insight into locations that are already facing constraints violations to some extent and need to be upgraded. The hosting capacity results are displayed as a heat map and in a form of report covering perceptive details that could easily be displayed on a utility's website to reach DER owners.

An overarching interface for managing all types of distributed energy resources:

- ✓ Distributed generation
- ✓ Energy storages
- ✓ Electric vehicles
- ✓ Demand Response
- ✓ Microgrids

Standard

The Standard offer of Grid Flexibility package focuses on the congested areas and relieving grid constraint violations in real time. By using Active Network Management and available DER flexibility utility can efficiently overcome the under/overvoltage, thermal overflow and undesired reverse power flows in the distribution grid caused by high local generation or consumption. The optimal Volt-Var-Watt strategy that is provided can also utilize traditional network assets in addition to the DER flexibility, so that the costs of operation and end customer disruption is minimized, while the renewable generation is maximized. The functionality makes grid flexible and unlocks new grid capacity for integrating DERs.

ESSENTIAL	STANDARD	PROGRESSIVE	ULTIMATE
<ul style="list-style-type: none"> ✓ DER Management ✓ DER Aggregation ✓ Hosting Capacity Analysis ✓ Customer Connection Analysis ✓ Single Pane of Glass HMI ✓ Templated Model Management ✓ ICCP ✓ OSIssoft PI Historian Integration ✓ Load Profile Generator Real-time Constraint Management Forecast WebDMD Network Planning Look-Ahead Constraint Mngmt IEC 61968-5 DERMS Integration LV Network Model Long-Term Forecast DMS Planning Applications Automatic Demand Flexibility LV DMS Planning Applications Big Data Connector <p>Available addons IEEE 2030.5 (R3.9) ArcFM Data Exporter</p>	<ul style="list-style-type: none"> ✓ DER Management ✓ DER Aggregation ✓ Hosting Capacity Analysis ✓ Customer Connection Analysis ✓ Single Pane of Glass HMI ✓ Templated Model Management ✓ ICCP ✓ OSIssoft PI Historian Integration ✓ Load Profile Generator ✓ Real-time Constraint Management ✓ Forecast ✓ WebDMD Network Planning Look-Ahead Constraint Mngmt IEC 61968-5 DERMS Integration LV Network Model Long-Term Forecast DMS Planning Applications Automatic Demand Flexibility LV DMS Planning Applications Big Data Connector <p>Available addons Load Profile Updater</p>	<ul style="list-style-type: none"> ✓ DER Management ✓ DER Aggregation ✓ Hosting Capacity Analysis ✓ Customer Connection Analysis ✓ Single Pane of Glass HMI ✓ Templated Model Management ✓ ICCP ✓ OSIssoft PI Historian Integration ✓ Load Profile Generator ✓ Real-time Constraint Management ✓ Forecast ✓ WebDMD ✓ Network Planning ✓ Look-Ahead Constraint Mngmt ✓ IEC 61968-5 DERMS Integration ✓ LV Network Model ✓ Long-Term Forecast DMS Planning Applications Automatic Demand Flexibility LV DMS Planning Applications Big Data Connector 	<ul style="list-style-type: none"> ✓ DER Management ✓ DER Aggregation ✓ Hosting Capacity Analysis ✓ Customer Connection Analysis ✓ Single Pane of Glass HMI ✓ Templated Model Management ✓ ICCP ✓ OSIssoft PI Historian Integration ✓ Load Profile Generator ✓ Real-time Constraint Management ✓ Forecast ✓ WebDMD ✓ Network Planning ✓ Look-Ahead Constraint Mngmt ✓ IEC 61968-5 DERMS Integration ✓ LV Network Model ✓ Long-Term Forecast ✓ DMS Planning Applications ✓ Automatic Demand Flexibility ✓ LV DMS Planning Applications ✓ Big Data Connector

The flexibility of DERs such as electric vehicles charging, some demand response programs and energy storage to some extent, is available only when its usage is scheduled upfront. To help capture the potential of this flexibility, the Grid Flexibility package in the Progressive edition provides Look Ahead and Look Ahead Constraint Management applications. This application set offers an effective tool for awareness and analysis of the future grid conditions, predicted constraint violations caused by DER production and an optimum DER dispatch solution to mitigate them. To resolve detected violations in the distribution grid, the application may propose a modification of the output schedule of grid-scale DER units, causing different charging and discharging rates of energy storages or curtailment of the PVs, modification of the net load shape of the microgrid connected to the distribution grid or modification of the production/consumption schedule of the aggregated customer-owned DERs.

Progressive

Progressive edition of Grid Flexibility package also adds value to the planning department by providing the Network Planning suite that allows planning engineers to leverage intelligent forecasting tools and network simulation modules, develop future network models better, plan for multiple DER integration scenarios, and ensure the grid is effectively reinforced while flexibility is maximized.

Ultimate

The highest level of grid automation can be unlocked with the Ultimate offer. This edition provides a module called Automatic Demand Flexibility. This functionality autonomously creates schedules for controlling DERs to address the peak demand reduction or maintain demand on the selected circuit below the desired level for the near real-time and look-ahead periods. The full suite of DMS planning applications that is also available in this edition assists the planning engineers in developing various studies of grid reinforcement and DER integration, enveloping the suite that enables non wire alternatives development.

All the offers from Grid Flexibility package are available within two different types of deployment, embedded in EcoStruxure™ ADMS solution or deployed separately as EcoStruxure™ DERMS solution, depending on the utility's preference in supporting DERMS use cases.



Conclusion

It is clear that the technology of the past will not take us into the future. Modernizing the grid means much more than updating wires and adding bi-directional capacity. Investing in technology that will help cope with the most recent and upcoming challenges is a must. Only by combining breakthroughs in all areas of energy management can utilities ensure a clean energy transition.

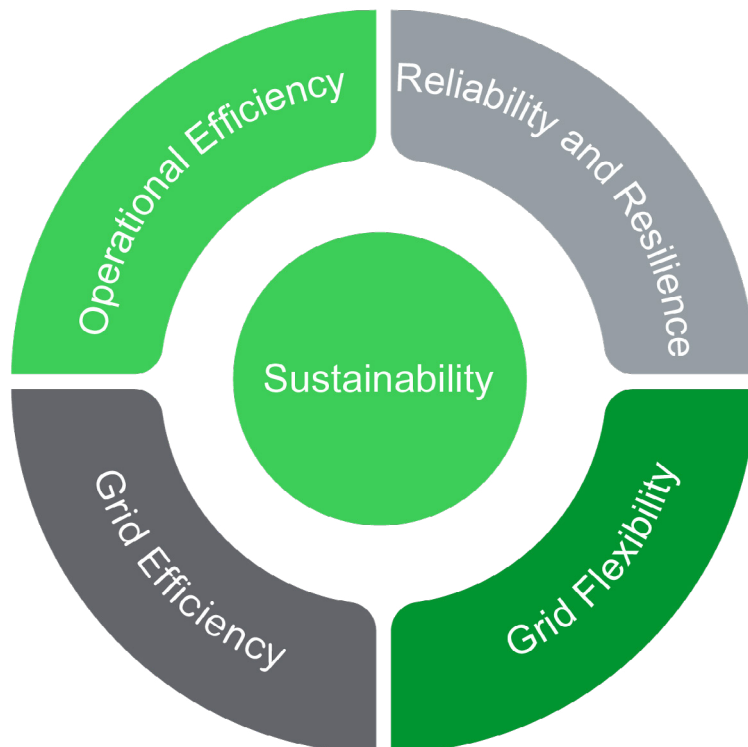
Schneider Electric's EcoStruxure™ ADMS solution which is based on four pillars: Operational Efficiency, Reliability & Resilience, Grid Efficiency, and Grid Flexibility fundamentally supports utilities throughout their energy transition towards sustainability in a stepwise approach. This paper describes the offered adoption path for each of the pillars, starting from primary use cases (available with Essential and Standard offers) up to the most challenging ones (Progressive and Ultimate).

Operational Efficiency is provided on a single network model for all voltage levels (HV/MV/LV) and all grid configurations, suitable for all geographies. Solution includes tools and processes that optimize efforts and time for model management. Workload is additionally reduced with SCADA data commissioning, templated data entering and comprehensive, off-the-shelf protocol analysis tool for communications troubleshooting.

Reliability and Resilience encompass embedded outage management and major event mitigation intelligence that improves decision making. Web clients for remote dispatching are available to ease the control room workload. Built-in field client with as-operated state of the grid improves safety of the field personnel, while intelligent electronic and switching/commissioning improves overall efficiency.

Grid Efficiency portfolio delivers more than 40 field-proven applications that provide monitoring, forecast, analysis, optimization, and planning of the grid. Robust state estimation provides awareness for the non-monitored parts of the grid in real time, including insight into the hidden load and local congestions. State-of-the-art closed loop engine implemented in production executes constraints management and energy efficiency.

Grid Flexibility unlocks the new possibilities by providing DER monitoring, forecasting, aggregation, flexibility insight and dispatch for all DERs present in the service territory. The grid's capacity to host new DER is boosted through apps that cover both the planning and operations aspect of utilizing the available DER flexibility.



Finally, with a strong global presence and satisfied customers across the world, Schneider Electric offers a personalized approach to utilities in need of a **partner for their digital transformation and sustainability journey**. By significantly investing in R&D and innovating, through new partnerships, products and services, Schneider Electric ensures long term added value to utilities. At Schneider Electric, we are proud of our dedicated team, with more than 1,000 motivated, highly competent, and hard-working professionals.

Learn more



EcoStruxure™ ADMS



IoT EcoStruxure at Enel Ensures Sustainability



IoT EcoStruxure: Power Restoration



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